1994-96

UNIVERSITY OF WISCONSIN MADISON

Letters and Science Degrees

Letters and Science Degrees

(From College of Letters and Science Bulletin)

The College of Letters and Science offers two basic degrees for students in the General Course and four other degrees for students in special programs. Students in the General Course, regardless of major, may earn either a Bachelor of Arts or a Bachelor of Science degree. The special degrees are: Bachelor of Arts-Journalism or Bachelor of Science-Journalism; Bachelor of Science-Applied Mathematics, Engineering, and Physics; Bachelor of Science-Chemistry; and Bachelor of Music.

Honors degrees may be earned in all of the above upon completion of the Honors Program. Majors completed in the General Course and for the Bachelor of Music degree will be posted on the transcript.

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UNIVERSITY OF WISCONSIN MADISON

1994-96

Bachelor of Arts Degree

Bachelor of Arts Degree

(From College of Letters and Science Bulletin)

The Bachelor of Arts curriculum requirements are:

ENGLISH. There are two parts to this requirement and both must be met.

1. All students must take an English placement test. If necessary, a semester course in composition or public speaking may be required. The records of transfer students are evaluated at the time of admission to determine whether or not this requirement has been met. Courses which may be used to meet this requirement are English 101, 105 or 118; Communication Arts 101 or 105.

Non-native speakers of English assigned to courses in English as a Second Language should consult the section in this bulletin on "International Students and Non-native Speakers of English."

2. Students must demonstrate command of expository English in their major and have this fact certified by the major department, or by the adviser in the case of an Individual Major.

Departments and Individual Major advisers have complete responsibility for testing such mastery of English and in taking appropriate steps to ensure that their students meet their standards.

It is the student's responsibility to declare a major officially and to make arrangements for certification of proficiency in expository English. Departments should post procedures to be followed. Students who delay in declaring a major and then find that they do not satisfy their department's expository English standards will not graduate until criteria are met.

NOTE: STUDENTS ENTERING UW-MADISON IN THE FALL OF 1998 OR LATER WILL BE REQUIRED TO SATISFY A FOUR-COURSE WRITING REQUIREMENT FOR THE BA DEGREE:

1. EXPOSITORY ENGLISH (6 CREDITS) ELEMENTARY LEVEL. These courses should be completed during the first four semesters in residence.

a. FIRST COURSE. A first-year, elementary-level composition course or exemption through placement test scores. This course will focus on writing mechanics and style.

b. *SECOND COURSE*. An additional faculty-taught, small-group, writing-intensive course at the elementary level.

2. WRITING-INTENSIVE (6 CREDITS) INTERMEDIATE LEVEL. These courses should be taken in the third year or beyond.

a. THIRD AND FOURTH COURSES. Completion of 6 credits of intermediate or advanced course work designated "writing intensive" in the Timetable. One of these courses must be in the major department or on a department-approved list of alternative courses.

FOREIGN LANGUAGE. Study of foreign language contributes in an important way to a broad education in a world where the overwhelming majority of people do not

speak or read English and where much of the knowledge may never appear in English.

Knowledge of a foreign language is important for an appreciation of the culture of the people using that language, and helps the student to understand the complexities of the native language. Both the B.A. and B.S. curricula encourage competence at the second-year college level in one foreign language. Students with sufficient preparation may be able to use the foreign language for study in their chosen discipline.

Two years of high school foreign language are required for admission to the University of Wisconsin-Madison. On rare occasion, students may be admitted with a foreign language deficiency, but they will be required to make up that deficiency by the time they earn their 60th degree credit, or they will not be allowed to continue.

A maximum of TWO UNITS OF AMERICAN SIGN LANGUAGE (ASL) may be used for the foreign language admission requirement. Students with certain disabilities may be admitted without high school foreign language and may apply for a substitution to the foreign language requirement by submitting required documentation to the College Disabilities Curricular Substitutions Committee. (See "Foreign Language: Substitutions for Students with Certain Disabilities" in the section on General College Requirements.)

The B.A. foreign language requirement may be met in either of two ways: (1) completion of the fourth unit in one language, or (2) completion of the third unit in one language and completion of the second unit in any other language. A unit is one year of high school work or one semester of college work. The following unit value will be applied to college-level language courses.

Language Courses According to Degree Credit	Unit Value for Satisfaction of Language Requirement
1-2 credit courses	0
3-6 credit courses	1
7 or more credits	2

In meeting the foreign language requirement, students may combine high school and college work as appropriate. This will allow the students to make full use of high school work in more than one foreign language, or will facilitate the study of a second foreign language that may not have been available in high school. Students who have learned a foreign language in a nonacademic setting (with no academic credits or units earned) may meet the foreign language requirement by successfully completing the appropriate level (or higher level) language course at the University or by successfully completing an appropriate attainment examination.

A maximum of TWO UNITS OF AMERICAN SIGN LANGUAGE (ASL) may be counted toward the foreign language requirements of the B.A. and B.S degrees in the College of Letters and Science. Students who use two units of American Sign Language to count for the foreign language requirement will need to complete through the third unit of another language to meet the foreign language requirement and be eligible for graduation.

All students working for a B.A. or B.S. in the College of Letters and Science must fulfill the foreign language requirement. Students with certain disabilities may be eligible for a substitution to the foreign language requirement. (See "Foreign Language: Substitutions for Students with Certain Disabilities" in the section on General College Requirements.)

NOTE: EFFECTIVE FALL 1998, a competency-based foreign language requirement will replace the current equivalency formula which equates a year of high school work with a semester of college work.

The B.A. degree foreign-language requirement will be as follows:

Four semesters of college-level work in one foreign language; or three semesters of college-level work in one foreign language and two semesters of college-level work in another foreign language; OR EQUIVALENT SCORES ON A DESIGNATED VALIDATION TEST.

Students who intend to enroll in a foreign language in which they have had previous noncollege instruction must take the UW-System placement test in that language. Students who enroll in a language course more than one level below their designated level will not be eligible for credit by course examination (retro credits).

MATHEMATICS. Mathematics is considered a principal tool of knowledge. Algebra and geometry provide a minimum of mathematics needed by an educated person in today's world and are required for admission to the University.

The Board of Regents of the UW System has established a policy that new freshmen who do not meet satisfactory minimal competencies in mathematics upon admission must begin to take remedial course work in mathematics during their first or second semesters and continue each semester thereafter, if necessary, until they have satisfactorily completed the mathematics proficiency requirement.

L&S freshmen whose mathematics placement test scores place them in Math 95 must complete that course or a higher level mathematics course by the time that the 30th degree credit is earned. Students who do not accomplish this will not be permitted to continue in the College of Letters and Science.

For the B.A. degree, three units of math are required. A unit is one year of high school work or one semester of college work. This will ordinarily include one unit each of algebra and geometry in high school and a third unit in mathematics, either in high school or college. Math 219 and courses in general mathematics or business mathematics will not count toward this requirement.

If the third unit includes statistics or computer sciences taken in high school, the student must contact the Statistics or Computer Sciences department to establish unit and/or degree credit. (See "Credit by Departmental Examination," in the section on General College Requirements.) If this work is taken on the college level, it must be at least a 3-credit course and must be taken in the departments of Mathematics, Computer Sciences, or Statistics.

Courses in sociometrics, econometrics, psychometrics, etc., do not apply.

BREADTH. A liberal education involves not only the nature and kinds of knowledge but also the purpose for which knowledge should be used. These considerations are embodied in the breadth or distribution requirement and call for knowledge in several fields of learning and their general methods and approaches to truth. The purpose of this breadth requirement is to ensure that a B.A. degree student will obtain an understanding of approaches in the humanities, social studies, biological sciences, and physical sciences adequate for use both as a citizen and as a specialist. Some breadth comes in courses from the student's major department.

Additional flexibility is achieved in the breadth requirement by accepting courses outside of the College of Letters and Science if they carry degree credit in the college. (See "100 Credit Rule" in the section on General College Requirements.)

The breadth requirement has three parts:

1. HUMANITIES (H). The minimum of 12 credits of humanities courses must include at least two courses in any kind of literature (L designation in this

bulletin and the Timetable) for a minimum of 6 credits. Literature courses are available in several departments, including the foreign language departments, ILS, and the departments of English, Comparative Literature, Literature in Translation, and Theatre and Drama. For specific information about literature courses, consult the Timetable, or course descriptions in this bulletin.

2. SOCIAL STUDIES (S). Minimum of 12 credits.

3. NATURAL SCIENCES. The minimum of 12 credits must include one course of at least 3 credits in the physical sciences (P), and one course of at least 3 credits in the biological sciences (B). Mathematics, computer sciences, and statistics at the elementary level may not be used to satisfy the science requirement. However, mathematics, computer sciences, and statistics beyond the elementary level may be used to satisfy the 6 remaining credits in science (N). (See "Course Designations and Breadth Requirement" in the section on General College Requirements.)

Interdivisional (I) courses count as elective credit only and do not count toward the Breadth requirement. Not more than 10 credits from any one department may be used in satisfaction of this requirement. (Note: This credit limitation does not apply to the Integrated Liberal Studies Program, which offers an integrated, interdisciplinary approach to the breadth requirement.) Cross-listed courses count in the total credits carried in each department in which they are listed.

Divisional designation and course level for each course are indicated in the Timetable and in the course descriptions in this bulletin.

The following symbols are used in this bulletin and the Timetable to indicate how courses count toward satisfying the breadth requirements:

B --Biological Science
H --Humanities
I --Interdivisional. Does not satisfy any breadth requirement.
L --Literature
N --Natural Science. Satisfies the Natural Science requirement but not the Biological or Physical Science requirement.
P --Physical Science
S --Social Studies
W --Either Social Studies or Natural Science
X --Either Humanities or Natural Science
Y --Either Biological Science or Social Studies
Z --Either Humanities or Social Studies
e --Meets the Ethnic Studies requirement

DEPTH (MAJOR STUDY). Every candidate for an L&S baccalaureate degree must satisfy a depth requirement encompassing a specified and approved major field of study. A student may elect a departmental major, a major in a recognized interdisciplinary program, or may develop an Individual Major.

ELECTIVES

Electives are all courses that do not meet a specific requirement for the degree or for the major.

G

TOTAL DEGREE CREDITS

A minimum of 120 degree credits is required for most baccalaureate degrees granted by the College of Letters and Science. The total credit requirements for some interdisciplinary majors is more than 120 degree credits. The college

allows degree credit, as well as placement credit, for the mastery of some L&S course work as demonstrated by appropriate tests. (See "Credit by Departmental Examination" in the section on General College Requirements.)

REPEAT OF HIGH SCHOOL OR COLLEGE COURSE WORK FOR DEGREE CREDIT

Without regard to any work taken in high school, students may enroll for degree credit in any course offered for degree credit by the college, provided they meet its prerequisites, and provided they have not already received college credit for this course or an equivalent or a higher level course in the same subject.

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UNIVERSITY OF WISCONSIN MADISON

1994-96

Bachelor of Science Degree

Bachelor of Science Degree

(From College of Letters and Science Bulletin)

The Bachelor of Science curriculum requirements are:

ENGLISH. There are two parts to this requirement and both must be met.

1. All students must take an English placement test. If necessary, a semester course in composition or public speaking may be required. The records of transfer students are evaluated at the time of admission to determine whether or not this requirement has been met. Courses which may be used to meet this requirement are English 101, 105 or 118; Communication Arts 101 or 105.

Non-native speakers of English assigned to courses in English as a Second Language should consult the section in this bulletin on "International Students and Non-native Speakers of English."

2. Students must demonstrate command of expository English in their major and have this fact certified by the major department, or by the major adviser in the case of an Individual Major.

Departments and Individual Major advisers have complete responsibility for testing such mastery of English and in taking appropriate steps to ensure that their students meet their standards.

It is the student's responsibility to declare a major officially and to make arrangements for certification of proficiency in expository English. Departments should post procedures to be followed. Students who delay in declaring a major and then find that they do not satisfy their department's expository English standards will not graduate until criteria are met.

NOTE: STUDENTS ENTERING UW-MADISON IN THE FALL OF 1998 OR LATER WILL BE REQUIRED TO SATISFY A FOUR-COURSE WRITING REQUIREMENT FOR THE BS DEGREE:

1. EXPOSITORY ENGLISH (6 CREDITS) ELEMENTARY LEVEL. These courses should be completed during the first four semesters in residence.

a. FIRST COURSE. A first-year, elementary-level composition course or exemption through placement test scores. This course will focus on writing mechanics and style.

b. *SECOND* COURSE. An additional faculty-taught, small-group, writing-intensive course at the elementary level.

2. WRITING-INTENSIVE (6 CREDITS) INTERMEDIATE LEVEL. These courses should be taken in the third year or beyond.

a. THIRD AND FOURTH COURSES. Completion of 6 credits of intermediate or advanced course work designated "writing intensive" in the Timetable. One of these courses must be in the major department or on a department-approved list of alternative courses.

FOREIGN LANGUAGE. Study of foreign language contributes in an important way to a broad education in a world where the overwhelming majority of people do not

speak or read English and where much of the knowledge may never appear in English. Knowledge of a foreign language is important for an appreciation of the culture of the people using that language, and helps the student to understand the structure and complexities of the native language. Both the B.A. and the B.S. curricula encourage competence at the second-year college level in one foreign language. Students with sufficient preparation may be able to use the foreign language for study in their chosen discipline.

Two years of high school foreign language are required for admission to the University of Wisconsin-Madison. On rare occasion, students may be admitted with a foreign language deficiency, but will be required to make up that deficiency by the time they earn their 60th degree credit, or they will not be allowed to continue.

A maximum of TWO UNITS OF AMERICAN SIGN LANGUAGE (ASL) may be used for the foreign language admission requirement. Students with certain disabilities may be admitted without high school foreign language and may apply for a substitution to the foreign language requirement by submitting required documentation to the College Disabilities Curricular Substitutions Committee. (See "Foreign Language: Substitutions for Students with Certain Disabilities" in the section on General College Requirements.)

The B.S. foreign language requirement may be met by completion of the third unit of foreign language in high school, or the equivalent third semester level college work. A unit is one year of high school work or one semester of college work. The following unit value will be applied to college-level language courses.

Language Courses According to Degree Credit	Unit Value for Satisfaction of Language Requirement
1-2 credit courses	0
3-6 credit courses	1
7 or more credits	2

In meeting the foreign language requirement, students may combine high school and college work as appropriate. Students who have learned a foreign language in a nonacademic setting (with no academic credits or units earned) may meet the foreign language requirement by successfully completing the appropriate level (or higher level) language course at the University or by successfully completing an attainment examination.

A maximum of TWO UNITS OF AMERICAN SIGN LANGUAGE (ASL) may be counted toward the foreign language requirements of the B.A. and B.S. degrees in the College of Letters and Science. Students who enter UW-Madison with two units of American Sign Language will need to complete through the third unit of another language in order to
meet the B.S. foreign language requirement and be eligible for graduation.

All students working for a B.A. or B.S. degree in the College of Letters and science must fulfill the foreign language requirement. Students with certain disabilities may be eligible for a substitution to the foreign language requirement. (See "Foreign Language: Substitutions for Students with Certain Disabilities in the section on General College Requirements.)

NOTE: EFFECTIVE FALL 1998, a competency-based foreign language requirement will replace the current equivalency formula which equates a year of high school work with a semester of college work.

The B.S. degree foreign language requirement will be as follows:

Three semesters of college-level work in one foreign language; or

EQUIVALENT SCORES ON A DESIGNATED VALIDATION TEST.

Students who intend to enroll in a foreign language in which they have had previous noncollege instruction must take the UW-System placement test in that language. Students who enroll in a language course more than one level below their designated level will not be eligible for credit by course examination (retro credits).

MATHEMATICS. Mathematics is a principal tool of knowledge. Algebra and geometry provide the minimum of mathematics needed by an educated person in today's world. Courses in general mathematics will not count toward the B.S. degree.

The Board of Regents of the UW System has established a policy that new freshmen who do not meet satisfactory minimal competencies in mathematics upon admission must begin to take remedial course work in mathematics during their first or second semesters and continue each semester thereafter, if necessary, until they have satisfactorily completed the mathematics proficiency requirement.

L&S freshmen whose mathematics placement test scores place them in Math 95 must complete that course or a higher level mathematics course by the time that the 30th degree credit is earned. Students who do not accomplish this will not be permitted to continue in the College of Letters and Science.

Since mathematics underlies quantitative work in all sciences, and the level of mathematical background required has been increasing steadily for many years in most fields of science, there is a substantial mathematics requirement in a B.S. degree. The requirement of five units of mathematics in the B.S. degree must be viewed as a minimum. Some majors will specify additional work in mathematics.

The five units of mathematics required for the bachelor of science degree must include one unit of high school algebra and one unit of high school geometry and at least two units BEYOND COLLEGE ELEMENTARY LEVEL chosen from mathematics, computer sciences and statistics. Math 219 does not count toward the B.S. mathematics requirement. NOTE: NO MORE THAN ONE UNIT EACH IN COMPUTER SCIENCES OR STATISTICS MAY BE USED TO MEET THE B.S. MATH REQUIREMENT.

The requirement may be met with five units of high school work, or the equivalent in college-level work. A unit is one year of high school work or one semester of college work. Students may combine high school and college work as appropriate. To establish unit and degree credit for high school computer sciences, statistics, and calculus courses the student must pass an appropriate Examination for Credit given by the computer sciences, statistics, or mathematics departments. (See "Credit by Departmental Examination" in the section on General College Requirements.)

Although it may be possible to complete this requirement in high school, most students will take one or more of these five units at the college level. If taken on the college level, the course(s) must be at the Intermediate Level and must be taken in the Departments of Mathematics, Statistics, or Computer Sciences.

Courses of one or two credits in the Departments of Statistics and Computer Sciences may not be used in satisfaction of the mathematics requirement. However, all courses in these departments beyond the elementary level may be used in partial satisfaction of the natural science (breadth) requirement. This is true whether the work is carried at the UW-Madison or at another college.

If this requirement is met through college-level work it must include at least two units of work beyond the elementary level as defined by the departments.

BREADTH. A liberal education involves not only the nature and kinds of knowledge, but also the purpose for which knowledge should be used. These

considerations are embodied in the breadth or distribution requirement, and call for knowledge in several fields of learning and their general methods and approaches to truth. The purpose of this breadth requirement is to ensure that a B.S. degree student will obtain an understanding of approaches in the humanities, social studies, biological sciences, and physical sciences adequate for use both as a citizen and as a specialist. Some breadth may come from courses in the student's major department.

The requirement may be met with 40 credits in the three broad areas of knowledge: Humanities, Social Studies, Natural Sciences (may include courses in mathematics, computer sciences, and statistics beyond elementary level). The following rules govern:

12 credits in the HUMANITIES (H). Must include at least two courses in any kind of literature (L designation in this bulletin and the Timetable) for a minimum of 6 credits. Literature courses are available in several departments, including the foreign language departments, ILS, and the departments of English, Comparative Literature, Literature in Translation, and Theatre and Drama. For specific information about literature courses, consult the Timetable or course descriptions in this bulletin.

12 credits in the SOCIAL STUDIES (S).

16 credits in the NATURAL SCIENCES. Must include at least 6 credits in the biological sciences (B) and at least 6 credits in the physical sciences (P). Mathematics (N), computer sciences (N), and statistics (N) courses may not be used to satisfy the physical science (P) (6 credit) part of this requirement. However,
mathematics, computer sciences, or statistics beyond the elementary level (E) may be used to satisfy the remaining credits (4) of this requirement. Science courses carrying an N (Natural Science) designation will satisfy the 4 remaining credits in natural science, but not the 6 credits required in physical and biological sciences. (See "Course Designations and Breadth Requirement" in the section on General College Requirements.)

Not more than 10 credits in one department may be counted in satisfying all of the breadth requirements. (Note: This credit limitation does not apply to the Integrated Liberal Studies Program, which offers an integrated, interdisciplinary approach to the breadth requirement.) Cross-listed courses count in the total credits carried in each department in which they are listed.

Work in the major may count toward this requirement.

I (Interdivisional) courses count as elective credit only and do not satisfy the breadth requirement.

The following symbols are used in this bulletin and the Timetable to indicate how courses count toward satisfying the breadth requirements:

B--Biological Science
H--Humanities
I--Interdivisional. Does not satisfy any breadth requirement.
L--Literature
N--Natural Science. Satisfies the Natural Science requirement but not the Biological or Physical Science requirement.
P--Physical Science
S--Social Studies
W--Either Social Studies or Natural Science
X--Either Humanities or Natural Science
Y--Either Biological Science or Social Studies
Z--Either Humanities or Social Studies
e--Meets the Ethnic Studies requirement

DEPTH (MAJOR STUDY). Every candidate for an L & S baccalaureate degree must satisfy a depth requirement encompassing a specified and approved major field

of study. A student may elect a departmental major, a major in a recognized interdisciplinary program, or may develop an Individual Major.

ELECTIVES

Electives are all courses which do not meet a specific requirement for the degree or for the major.

TOTAL DEGREE CREDITS G
A minimum of 120 credits is required for most baccalaureate degrees granted by the College of Letters and Science. The total credit requirements for some interdisciplinary majors is more than 120 degree credits. The college allows degree credit, as well as placement credit, for the mastery of some L & S course work as demonstrated by appropriate achievement tests. (See "Credit by Departmental Examination" in the section on General College Requirements.)

REPEAT OF HIGH SCHOOL OR COLLEGE COURSE WORK FOR DEGREE CREDIT

Without regard to any work taken in high school, students may enroll for degree credit in any course offered for degree credit by the college, provided they meet its prerequisites, and provided they have not already received college credit for this course or an equivalent or a higher level course in the same subject.

ID: UPBLS-4.1.

UNIVERSITY OF WISCONSIN MADISON 1994-96

Mathematics

Mathematics

(From College of Letters and Science Bulletin)

213 Van Vleck Hall, 263-3053

Professors Ahern, Angenent, Askey, Assadi, Bauman, Beck, Benkart, Bleicher, de Boor, Bramson, Brauer, Brualdi, Buck (emeritus), Bucklew, Chover (emeritus), Conner, Crowe (emeritus), Dickey, Fadell (emeritus), Forelli, Forstneric, Griffeath, Gunji, Harvey, Hellerstein, Husseini, Isaacs, A. Johnson, M. Johnson, Keisler, Kuelbs, Kunen, Kurtz, Levin, Levy, McMillan, Meyer, Miles, Millar, Miller, Nagel, Ney, Nohel, (emeritus) Orlik, Osborn, Parter, Passman, Rabinowitz, Rall, Rider, Robbin, Rosay, M. Rudin (emeritus), W. Rudin (emeritus), Schneider (emeritus), Seeger, Shea, Shen, Slemrod, Smart, Solomon, Souganidis, Strikwerda, Terao, Terwilliger, Turner, Uhlenbrock, Vanden-Broeck, Voichick, Wainger, Wilson, Young (emeritus), Zelmanov; Associate Professors Adem, Joseph, Lempp, Pemantle, Ron, Tzavaras, Zariphopoulou-Souganidis; Assistant Professors Andradottir, Ilmanen, Mari-Beffa, Neuhauser, Oh, Ram.

Undergraduate adviser in the major (academic year only): Professor M. Voichick, 316 Van Vleck, 262-3221.

CERTIFICATION OF PROFICIENCY IN EXPOSITORY ENGLISH IN THE MAJOR: A math major should request certification through the Advising Secretary in Van Vleck Hall at the beginning of the student's senior year. The mathematics department will then issue such certification unless the student has been identified by an instructor as being deficient in the use of English. In the case of such a report, the chairman of the mathematics department will appoint a committee of two to prescribe a course of action.

COURSES THAT COUNT TOWARD THE 15 CREDITS OF UPPER-LEVEL WORK IN THE MAJOR: Mathematics courses numbered above 306 (except for Math 425) taken in residence count toward this requirement.

M

REQUIREMENTS FOR THE MATHEMATICS MAJOR

A detailed description of the mathematics major program is in the Guidebook for Undergraduate Math Majors available in 203 Van Vleck Hall.

ACCEPTANCE. To be accepted as a major in mathematics a student must complete Math 221, 222, and 223 (or equivalent sequence) with a grade-point average of 2.5 or better in this sequence. However, a somewhat higher grade-point average is advisable. Soon after completing Math 223, math majors should have their math advisers complete the Major Declaration Form and, perhaps later, but by the beginning of the senior year, the Math Major Approval Form. The former indicates acceptance into the major and the latter specifies which major requirements the student will satisfy. Majors are assigned math advisers through the Mathematics Advising Secretary in 203 Van Vleck Hall.

MAJOR REQUIREMENTS: NON-HONORS

The student chooses one of two options. Since both options allow considerable flexibility, students should plan their programs with the advice of their math advisers. Indeed, those following Option II must have their programs formally approved by their mathematics advisers. Option II emphasizes the applications of mathematics, and those following Option I are also encouraged to take courses in other departments which involve the application of mathematics.

OPTION I: Six mathematics courses numbered above 306, excluding 425 and 490. These six courses must include (1) 320 or 340, and (2) three courses numbered above 500 including at least two of the following: 521, 541, 551.

It is recommended that students preparing for graduate work in mathematics satisfy a, b, and c below.

a. 340, 521, 522, 541, 542
b. 551 or 561
c. Two other courses, to complete a varied program

Students who plan to enter a mathematics Ph.D. program should acquire a reading knowledge of two foreign languages as early as possible. For mathematics the important languages are French, German, Russian and, possibly, Italian.

OPTION II (for students interested in a particular area of application):
a. Four courses in some area of application of mathematics, including at least three courses at the intermediate or advanced level, selected with the approval of the student's mathematics adviser.
AND
b. Six mathematics courses numbered above 306, excluding 425 and 490, selected with the approval of the student's mathematics adviser, including 320 or 340 and two courses numbered above 500.

No courses may be used to fulfill both (a) and (b).

Approval of a program under Option II will be required before a significant part of the program is completed and changes in the approved program will require prior consent of the mathematics adviser. The program is formally approved on the Math Major Approval Form, a copy of which is sent to the Office of the Registrar.

Sample programs for Option II are in the Guidebook for Undergraduate Math Majors. The areas of application in these sample programs include: computer sciences, chemistry, physics, statistics, actuarial mathematics, meteorology, economics, ecology, genetics, forestry, business, and engineering.

MAJOR REQUIREMENTS: HONORS

To earn the B.A. or B.S. with honors in mathematics a student must complete (a) the L&S general course degree requirements, (b) the Honors Program requirements, and (c) the mathematics honors curriculum.

MATHEMATICS HONORS CURRICULUM. Honors majors must successfully complete with grades of B or better Math 340H (or 340 credit by examination), 521H, 522H, 541H, 542H, or their equivalents, together with 551 or 4 credits of 490. They must also complete with grades of B or better 6 credits of Math 681-682 (Senior Honors Thesis) or the following: 1 credit of Math 490 and 6 credits in 623, 629, 632, 641, or math courses numbered 700 or above.

See the later section Honors Courses for information about the rotation of honors courses and admission into honor sections.

Teacher Preparation. Students interested in teaching mathematics at the primary or secondary level should consult the School of Education Bulletin.

GENERAL INFORMATION

Mathematics is classified both with the humanities and the sciences. Its position among the humanities is based on the study of mathematics as one of the liberal arts for more than two thousand years. Far from becoming stagnant, mathematics offers more new and challenging frontiers than at any time in its long history--with totally new fields, requiring new techniques and ideas for exploration.

The place of mathematics among the sciences is well founded. The natural sciences have invariably turned to mathematics for techniques needed to explore the consequences of scientific theories. In the last few decades social scientists have increasingly found higher mathematics of value in their training and research.

Although job opportunities have varied with the changes in the national economy, in recent years graduating math majors have obtained employment in a variety of jobs in business, industry, and governmental agencies and also have obtained teaching positions at the secondary school level (such teaching positions normally require teaching certification). Others have continued their educations at the graduate level in mathematics and other fields. Departments in a variety of fields which use mathematics, including some in the social and biological sciences as well as in engineering and the physical sciences, are interested in attracting math majors into their graduate programs. Math Ph.D.s obtain academic positions at the college and university level and nonacademic positions entailing consulting and research. The math major requirements are flexible enough to allow preparation for various goals.

Students interested in mathematics should also consider related programs offered by the Computer Sciences Department, the Statistics Department, the School of Business, the School of Education, and the Applied Mathematics, Engineering and Physics major.

PREREQUISITES

Four levels of preuniversity competence are specified below. (Levels of competence, except superior, are measured by high school preparation and by the placement examinations described below.) Prospective students of mathematics, science, and engineering should achieve advanced mathematical competence (Levels 3a and 3b) before coming to the University so that they may enroll in Math 221 at the start of the freshman year. Students with only minimum and intermediate mathematical competence are strongly advised to remove this deficiency by independent study through the UW-Extension or by enrolling for the summer session preceding their freshman year.

Students must be able to apply all of the listed competencies in problem solving situations, and to select and combine techniques appropriate to the problem.

1. MINIMUM MATHEMATICAL COMPETENCE. From algebra and arithmetic: an understanding of the axioms that underlie arithmetic, the decimal system and its use in calculation, and the definition and elementary properties of rational numbers; basic algebraic skills, including special products, factoring, positive integral exponents, and the manipulation of algebraic fractions; setting up and solving linear equations and inequalities; from geometry: axioms, theorems, and proofs of theorems concerning straight lines, triangles, and circles; graphing of linear equations and interpretation of

systems of two linear equations; measurement formulas for the perimeter, circumference, area, and volume of common two-and three-dimensional figures.

2. INTERMEDIATE MATHEMATICAL COMPETENCE. The competencies of Level 1, together with: equations, laws of rational exponents, and radicals; additional topics in factoring; zero product rule; setting up and solving quadratic equations; complex numbers; algebra of polynomials and rational expressions; setting up and solving simultaneous linear equations and inequalities; graphing, including linear and quadratic polynomials; definition and application of absolute value and of scientific notation; definition and elementary properties of logarithms.

3A. ADVANCED MATHEMATICAL COMPETENCE--ALGEBRA. The competencies of Levels 1 and 2, together with: functions: definition, domain, range, algebraic combinations, composition, inverse, symmetries, translations, graphs; theory of polynomial equations, including the remainder and factor theorems; solution of simultaneous linear equations; equivalent and partially equivalent equations and systems of equations; equations solvable by linear and quadratic techniques; exponential and logarithmic functions, equations, and inequalities; nonlinear inequalities; analytic geometry of conic sections; representation of plane curves and regions by equations or inequalities; sequences, sums, and series, including arithmetic and geometric sequences and series; mathematical induction.

3B. ADVANCED MATHEMATICAL COMPETENCE--TRIGONOMETRY. The competencies of Levels 1 and 2, together with: functions: definition, domain, range, algebraic combinations, composition, inverse, and graphs; trigonometric functions of a real number including their basic properties and graphs; trigonometric equations and identities; geometric significance of the trigonometric functions and elementary applications; polar form of complex numbers and DeMoivre's Theorem.

4. SUPERIOR MATHEMATICAL COMPETENCE. Some high schools may find it possible to offer additional topics to able, well-prepared students who have already achieved advanced mathematical competence. For example, courses in probability and statistics, analytic geometry, number theory, calculus, or discrete mathematics are suitable for these high school students.

Advanced placement credit. A student who has completed a substantial calculus course in high school may earn university degree credit for Math 221 or for 221 and 222 by one of the following: (1) the College Board calculus advanced placement exam; (2) the Math Department calculus advanced placement exam; or (3) advanced placement tests given in conjunction with calculus courses at certain Wisconsin high schools.

PLACEMENT

Each entering student (freshman or transfer student without transfer credit for a specific mathematics course) who will take Mathematics 95, 99, 100, 101, 112, 113, 114, 171, 210, 211, 221, or 275 is required to take the placement examinations in mathematics before enrolling in any of these courses. Placement in a course is not guaranteed on the basis of the high school record alone; placement in the course appropriate to the student's needs and competence will be made by the Department of Mathematics on the basis of both high school record and placement scores.

EXPECTED LEVELS AND COURSES. A student with three years of high school mathematics may possibly achieve intermediate competence and be placed in Math 112, 114, or 171. A student with four years of high school mathematics may possibly achieve advanced competence and be placed in Math 210, 211, 221, or 275. Students with three or four years of years of high school mathematics who do not achieve these competencies will be placed in lower level courses.

k. Wisconsin 1994-96

REMEDIAL MATHEMATICS. Students may be placed in the remedial math course, Math 95, if the student's ACT (or SAT) math scores and the mathematics placements scores are low. Math 95 does not carry degree credit. L&S students whose mathematics placement test scores place them in Math 95 must complete that course or a higher level mathematics course by the time the 30th degree credit is earned.

TOUCHTONE REGISTRATION INFORMATION. The touchtone registration system checks for the appropriate math placement scores and the course prerequisites for the following Math courses: 95, 99, 100, 101, 112, 113, 114, 171, 210, 211, and 221. The system will also check for the prerequisites and appropriate student classification for Math 130, 131 and 132. Also students who are not in an honors program will need math department authorization to enroll in honors sections of Math 221, 222, and 223. In addition students may need math department authorization to enroll in Math 171, 272, 275, 276 or 298.

DEPARTMENTAL POLICY REGARDING A D GRADE. A student should repeat on a refresher basis a math course in which a grade of D is earned and which serves as a prerequisite to another course to be elected. A D grade commonly signifies some achievement but usually denotes a weak foundation upon which to build subsequent course work.

AUDIT

Normally students are not permitted to audit elementary and intermediate level math courses. Students are permitted to audit advanced math courses.

HONORS COURSES

It is expected that Math 275 will be offered in place of an honors section of Math 221 semester I, 1994-95, and Math 276 in place of an honors section of Math 222, semester II, 1994-95. It is possible that this arrangement will continue in subsequent years. In any case, it is anticipated that honors sections of Math 222 will be offered every first semester and honors sections of Math 223, every semester. In the case that Math 275 and 276 are not offered, it is expected that honors sections of Math 221 will be offered every first semester and honors sections of Math 222 will be offered every semester. In advanced mathematics courses honors sections or sections in which honors credit is available normally will be offered in the following rotation: Sem I: 340H, 521H, 541H; Sem II: 340H, 522H, 542H. Math 681 and 682 are taken for honors credit. In addition, students may enroll for honors credit in 490, 551, 552, 623, 629, and 632 (listed as "Course recommended for Honors" in the Timetable). Other 400-, 500-, and 600-level mathematics courses may occasionally be listed as "honors credit available" in the Timetable. A graduate course will carry honors credit.

ADMISSION TO HONORS COURSES. In order to be admitted to an honors section or enroll for honors credit a student must have a 3.5 average in previous mathematics courses numbered 221 and above. A student is not required to be in the Honors Program nor an honors major in order to enroll in an honors section except for Math 681 and 682, which are limited to students in the Honors Program. However, students who are not in an honors program will need math department authorization to enroll in honors sections of Math 221, 222, 223.

WILLIAM LOWELL PUTNAM COMPETITION. This is an annual international mathematics competition for undergraduates, based on originality and cleverness rather than sophisticated mathematical knowledge. Students interested in preparation for this examination may enroll for credit in Math 490, Undergraduate Seminar, in the fall semester, or may attend informally. The

U. Wisconsin 1994-96

instructor selects a team to represent UW-Madison, and others may be entered as individuals by the instructor.

COMPUTING FACILITIES

The Mathematics Campus Microcomputer Instructional Lab in Room 101, Van Vleck Hall (access at Plaza level), contains a variety of computers and is available to students, faculty and staff. Required computing for mathematics courses has first priority.

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UNIVERSITY OF WISCONSIN MADISON

Mathematics: Courses

Mathematics: Courses

(From College of Letters and Science Bulletin)

SCHEDULE OF COURSES

Courses are normally offered according to the following schedule; however, changes may be necessary because of staffing difficulties or low enrollment.
Every semester: 101, 112, 113, 130, 131, 132, 210, 211, 213, 221, 222, 223, 235, 303, 319, 321, 322, 340, 431, 441, 461, 475, 521, 525, 541, 551, 632, 681, 682, 699;
Every first semester: 99, 114, 309, 313, 443, 473, 490, 513, 623;
Every second semester: 100, 310, 514, 522, 542, 571, 629;
First semester even odd years: 415;
Second semester odd years: 419.
Second semester even years: 561, 567.

REMEDIAL

095 Fundamental Mathematical Skills. I or II; 3 cr. Covers the fundamental mathematics necessary both as survival skills in daily life and as tool for success in college. Includes arithmetic procedures and their applications. Intended for students fulfilling the remediation requirements in mathematics. P: Remedial status as determined by the University; does not count for degree credit. Open to Fr.

Note that Math 95 does not carry degree credit but counts 3 credits for determining fees and a student's semester study load. L&S students whose mathematics placement test scores place them in Math 95 must complete that course or a higher level mathematics course by the time the 30th degree credit is earned.

ELEMENTARY COURSES

099 Algebra. I; 2 cr (E). Review of fractions and signed numbers and some Math 101 material. For students with mastery of fundamental arithmetic skills, but without the competence in algebra necessary for Math 101. Math 99 and 100 together amount to one unit for the L & S mathematics requirement. P: Minimum math comp (1 unit ea HS alg & geom) & suitable placemt scores. Open to Fr. Stdts may not receive cr for both Math 99 & 101.

100 Algebra. II; 2 cr (E). Continuation of Math 99. The sequence Math 99-100 covers the material of Math 101. P: Math 99. Open to Fr. Stdts may not receive cr for both Math 100 & 101.

k Wisconsin 1994-96

101 Intermediate Algebra. I, II, SS; 4 cr (E). Polynomial products and factoring, algebraic fractions, linear and fractional equations and inequalities, systems of linear equations, rational and real exponents, radicals, quadratic equations, logarithms, parabolas. P: Minimum math comp (1 unit ea HS alg & geom) & satisfactory placemt scores. Open to Fr. Stdts may not receive cr for both Math 99 & 101, nor for both Math 100 & 101.

112 Algebra. I, II, SS; 3 cr (E). Polynomial equations, remainder and factor theorems, functions, graphs of functions, simultaneous linear equations, logarithm and exponential functions, sequences and series, mathematical induction, binomial theorem. P: Intmed math comp (usually 3 units of HS math) & suitable placement scores, or Math 100 or 101. Open to Fr. Stdts may not receive cr for both Math 112 & 114.

113 Trigonometry. I, II, SS; 2 cr (E). Graphs, properties and geometric significance of trigonometric functions of a real variable, trigonometric equations and identities, applications, trigonometric form of complex numbers, DeMoivre's theorem. P: Adv Math comp-algebra & suitable placement scores, or completion of Math 112. Stdts may not receive cr for both Math 113 & 114. Open to Fr.

114 Algebra and Trigonometry. I; 5 cr (E). Covers Math 112 and Math 113. Not recommended for students with less than an AB in Math 100 or 101. P: Intmed math comp (usu 3 units HS math) & suitable plct scores, or Math 100 or 101. Open to Fr. Stdts may not receive cr for both Math 112 & 114 nor for both 113 & 114.

171 Topics in Precalculus. I, II; 2-5 cr (E). Topics in college algebra, trigonometry, precalculus, and elementary calculus. P: Will vary according to topic. Open to Fr.

NOTE ON MATH 130, 131 AND 132

Courses 130, 131, 132 are designed for future teachers, and are open only to students in the School of Education, and the School of Family Resources and Consumer Sciences. These courses may not be used for satisfaction of degree requirements in the College of Letters and Science.

130 Arithmetical Problem Solving. I, II; 3 cr. This course emphasizes problem solving and mathematical writing. Topics will be chosen from: rational numbers; decimals; logic and set theory; place value; scientific notation; number theory; functions and relations; exponentiation; algebra. P: Open to Fr. Intermed math comptnce (usually 3 units HS math)&placemnt score,or Math 100 or 101. Does not count toward degree req in L&S. Open only to stdts in Educ & FRCS.

131 Geometrical Inference and Reasoning. I, II; 3 cr. Discovery, conjecture, and proof through geometric explorations in the following areas: lines; polygons; formal constructions; tesselations; polyhedra; symmetry; rigid motions; lengh; area and volume. P: Open to Fr. Intermed math comptnce (usually 3 units HS math)&placemnt score,or Math 100 or 101. Does not count toward degree req in L&S. Open only to stdts in Educ & FRCS.

132 Mathematical Models. I, II; 2 cr. Developing and using mathematical models to solve problems. (1) Using equations and algebraic and analytic tools; (2)

probabilistic reasoning and descriptive statistics. P: Open to Fr. Intermed math comptnce (usually 3 units HS math)&placemnt score,or Math 100 or 101. Does not count toward degree req in L&S. Open only to stdts in Educ & FRCS.

INTERMEDIATE AND ADVANCED COURSES

CALCULUS SEQUENCES. The Math 221-222 sequence is the first two semesters of the standard three-semester calculus sequence, 221-222-223, normally required for all higher level math courses, and should be taken by those preparing for major study in mathematics, the physical sciences, computer sciences, or engineering. It is also recommended for students in the social and life sciences who may want a more substantial introduction to calculus than offered in the Math 211-213 sequence. The Math 211-213 sequence does not prepare the student for higher level mathematics courses and does not provide adequate math background for some courses in related fields. Transferring from the 211-213 sequence into the 221-222-223 sequence is usually quite awkward. Math 211 is not adequate preparation for Math 222 and students may not earn credit for both Math 211 and 221; students may not earn full degree credit for both Math 213 and 222 or for both 213 and 223. Transfer students and graduate students with three semesters of calculus that did not include an introduction to differential equations should consider Math 235, which provides the differential equations part of Math 223. Math 275 in semester I, 1994-95, and Math 276 semester II, 1994-95, may be offered in place of honors sections of Math 221 and 222, respectively. This arrangement may continue 1995-96.

PRE-BUSINESS MATHEMATICS REQUIREMENTS. For many majors in the School of Business, Math 210 and 211 or 210 and 221 satisfy this requirement. However some business majors require the Math 221-222 sequence. Interested students should obtain more detailed information from the School of Business.

210 Topics in Finite Mathematics. I, II, SS; 3 cr (N-I). Topics in finite mathematics including elementary matrix algebra, linear programming, introduction to probability, and mathematics of finance. Students planning to take both Math 210 and Math 211 are advised to take Math 210 first. Primarily for students in social and biological science and prebusiness. Students preparing for advanced study in mathematics should take Math 221-222-223 rather than Math 210-211-213. P: (I) Adv math comp-algebra & suitable plcmt scores or Math 112 or 114 & (II) Adv math comp-trig & suitable plcmt scores or Math 113 or 114. Open to Fr.

211 Calculus. I, II, SS; 5 cr (N-I). Essential concepts of differential and integral calculus; trigonometric, exponential and logarithmic functions; functions of several variables. Primarily for students in social and biological science and prebusiness. Students preparing for advanced study in mathematics should take Math 221-222-223 rather than Math 210-211-213. P: (I)Adv math comp-alg&suitable plct scores, or Math 112 & (II)Adv math comp-trig&suitable plct scores, or Math 113; or Math 114. Open to Fr. May not rec cr for Math 211 & 221.

213 Calculus and Introduction to Differential Equations. I, II; 3 cr (N-I). Techniques of integration, multiple integrals, infinite sequences and series, first order differential equations, two-dimensional systems of differential equations, difference equations, with models from and applications in business and the social and biological sciences. P: Math 211 or 221. Stdts may not receive full degree cr for both Math 222 and 213 or both Math 223 and 213.

219 What is Mathematics?. Irr; 3 cr (N-I). The nature of mathematics from a

multidisciplinary perspective: history, philosophy and aesthetics of mathematics and some sociological and economic aspects of its current practice and relation to the sciences. Does not count toward satisfaction of the L&S BS mathematics requirements. P: 3 units of HS math or equiv. Some essay writing at the college level strongly recommended. Open to Fr.

221 Calculus and Analytic Geometry. I, II, SS; 5 cr (N-I). Introduction to differential and integral calculus and plane analytic geometry; applications; transcendental functions. P: (I)Adv math comp-alg&suitable plct scores, or Math 112 & (II)Adv math comp-trig&suitable plct scores, or Math 113; or Math 114. Open to Fr. May not rec cr for Math 211 & 221.

222 Calculus and Analytic Geometry. I, II, SS; 5 cr (N-I). Techniques of integration, conic sections, polar coordinates, vectors, two and three dimensional analytical geometry, infinite series. P: Math 221. Stdts may not receive full degree cr for Math 222 & 213. Open to Fr.

223 Calculus and Analytic Geometry. I, II, SS; 5 cr (N-I). Introduction to calculus of functions of several variables; multiple integrals; introduction to differential equations. P: Math 222. Stdts may not receive full degree cr for both Math 223 & 213 or both Math 223 & 234 or both Math 223 & 235.

234 Calculus--Functions of Several Variables. Irr; 3 cr (N-I). Introduction to calculus of functions of several variables; multiple integrals. Equivalent to the calculus part of Math 223. P: Math 222. Stdts may not receive cr for both Math 223 & Math 234.

235 Brief Introduction to Differential Equations. I, II; 2 cr (N-I). First and second order differential equations with physical examples; linear differential equations with constant coefficients; applications and numerical approximations. Equivalent to the differential equations part of Math 223. P: Math 222. Stdts may not receive cr for both Math 223 and Math 235.
272 Topics in Elementary Calculus. I, II; 2-5 cr (N-I). Topics in elementary calculus. P: Will vary according to topic. Open to Fr.

275 Topics in Calculus I. I, II; 2-5 cr (N-I). Topics in first semester calculus. P: Will vary according to topic.

276 Topics in Calculus II. I, II; 2-5 cr (N-I). Topics in second semester calculus. P: Will vary according to topic.

298 Directed Study in Mathematics. I, II; 1-3 cr. Cr/N. P: Cons inst. Open to Fr.

303 Theory of Interest and Life Insurance. I, II; 3 cr (N-I). Application of calculus to compound interest and insurance functions; interest compounded discretely and continuously; force of interest function; annuities payable discretely and continuously; bonds and yield rates; life tables, life annuities, single and annual premiums for insurance and annuities; reserves. P: Math 223 or con reg, or cons inst.

309 Introduction to Mathematical Statistics. (Crosslisted with Stat 309. See Stat 309 for course information.)

310 Introduction to Mathematical Statistics. (Crosslisted with Stat 310. See Stat 310 for course information.)

U. Wisconsin 1994-96

313 Actuarial Mathematics. I; 3 cr (A). Ordinary differences and related operators, divided differences; polynomial interpolation, summation, numerical differentiation, osculatory interpolation, approximate integration; difference equations. P: Math 223.

319 Techniques in Ordinary Differential Equations. I, II, SS; 3 cr (N-A). Review of linear differential equations; series solution of linear differential equations; boundary value problems; Laplace transforms; possibly numerical methods and two dimensional autonomous systems. P: Math 223.

320 Linear Mathematics. Irr; 3 cr (N-A). Introduction to linear algebra, including matrices, linear transformations, eigenvalues and eigenvectors. Linear systems of differential equations. Numerical aspects of linear problems. P: Math 223. Credit may not be received for both Math 320 & 340.

321 Applied Mathematical Analysis. I, II; 3 cr (N-A). Vector analysis: algebra and geometry of vectors, vector differential and integral calculus, theorems of Green, Gauss, and Stokes; complex analysis: analytic functions, complex integrals and residues, Taylor and Laurent series. P: Math 223.

322 Applied Mathematical Analysis. I, II; 3 cr (N-A). Sturm-Liouville theory; Fourier series, including mean convergence; boundary value problems for linear second order partial differential equations, including separation of variables and eigenfunction expansions. P: Math 321.

340 Elementary Matrix and Linear Algebra. I, II, SS; 3 cr (N-A). Matrix algebra, linear systems of equations, vector spaces, sub-spaces, linear dependence, rank of matrices, determinants, linear transformations, eigenvalues and eigenvectors, diagonalization, inner products and orthogonal vectors, symmetric matrices. P: Math 223. Credit may not be received for both Math 320 & 340.

371 Basic Concepts of Math. 3 cr (N-A). Informal treatment of propositional and first-order logic. Proof techniques. Naive set theory. Relations and function. Peano axioms. Construction of the real numbers from the natural numbers. Countable and uncountable sets. Axiom of Choice and Zorn's Lemma. P: Math 340 or con reg. Irr.

415 Mathematics for Dynamic Modeling. I, Odd Yrs; 3 cr (N-A). Techniques for formulating models of time dependent phenomena in the social and biological sciences as difference and differential equations are considered. The underlying unity of the formulations emphasized. Topics involving differential equations and linear algebra. P: Math 320 or 340, or other knowledge of matrix algebra.

419 Intermediate Differential Equations. II, Even Yrs; 3 cr (N-A). Systems of differential equations, stability, qualitative behavior, and physical examples. P: Math 320 or 340.

425 Introduction to Combinatorial Optimization. (Crosslisted with Comp Sci, Ind Engr 425. See Comp Sci 425 for course information.)

431 Introduction to the Theory of Probability. (Crosslisted with Stat 431.) I, II, SS; 3 cr (N-A). Probability in discrete sample spaces; combinatorial analysis; conditional probabilities, stochastic independence, Laplace limit theorem, Poisson distribution, laws of large numbers, random variables, central limit theorem, applications. P: Math 223.

441 Introduction to Modern Algebra. I, II; 3 cr (A). The integers, emphasizing general group and ring properties. Permutation groups, symmetry groups, polynomial rings, leading to notions of abstract groups and rings. Congruences, computations, including finite fields and applications. Emphasis on concepts and concrete examples and computations, not complicated proofs. P: Math 340. Stdts who have passed Math 541 are not permitted to take Math 441 for credit.

443 Applied Linear Algebra. I; 3 cr (N-A). Review of matrix algebra. Simultaneous linear equations, linear dependence and rank, vector space, eigenvalues and eigenvectors, diagonalization, quadratic forms, inner product spaces, norms, canonical forms. For students whose main field of interest is not pure mathematics. Discussion of numerical aspects and applications in the sciences. P: Math 320 or 340 or cons inst.

461 College Geometry I. I, II; 3 cr (N-A). An introduction to Euclidean or non-Euclidean geometry at the college level. P: Math 223.

473 History of Mathematics. (Crosslisted with Hist Sci 473.) I; 3 cr (H-A). An historical survey of the main lines of mathematical development. P: Cons inst.

475 Introduction to Combinatorics. (Crosslisted with Comp Sci, Stat 475.) I, II; 3 cr (N-A). Problems of enumeration, distribution, and arrangement. Inclusion-exclusion principle. Generating functions and linear recurrence relations. Combinatorial identities. Graph coloring problems. Finite designs. Systems of distinct representatives and matching problems in graphs. Potential applications in the social, biological, and physical sciences. Puzzles. Problem solving. P: Math 320 or 340 or cons inst.

490 Undergraduate Seminar. I; 1-3 cr (N-A). Problem solving techniques. P: So st and cons inst.

491 Topics in Undergraduate Mathematics. Irr; 3 cr (A). Topics will vary. P: Math 223 and cons inst.

513 Numerical Linear Algebra. (Crosslisted with Comp Sci 513. See Comp Sci 513 for course information.)

514 Numerical Analysis. (Crosslisted with Comp Sci 514. See Comp Sci 514 for course information.)

521 Advanced Calculus. I, II, SS; 3 cr (N-A). Fundamental notions of limits, continuity, differentiation, and integration, for functions of one or more variables, convergence and uniform convergence of infinite series, and improper integrals. P: Math 340 or con reg.

522 Advanced Calculus. II; 3 cr (N-A). Differentials and Jacobians, transformation of coordinates and of multiple integrals, line and surface integrals. P: Math 521.

525 Linear Programming Methods. (Crosslisted with Comp Sci, Ind Engr, and Stat 525. See Comp Sci 525 for course information.)

541 Modern Algebra. I, II; 3 cr (N-A). Groups, normal subgroups, Cayley's theorem, rings, ideals, homomorphisms, polynomial rings, abstract vector spaces. P: Math 320 or 340 or cons inst.

542 Modern Algebra. II; 3 cr (N-A). Field extensions, roots of polynomials,

splitting fields, simple extensions, linear transformations, matrices, characteristic roots, canonical forms, determinants. P: Math 541.

551 Elementary Topology. I, II; 3 cr (N-A). Topological spaces, connectedness, compactness, separation axioms, metric spaces. P: Math 223.

552 Elementary Geometric and Algebraic Topology. Irr; 3 cr (N-A). Introduction to algebraic topology. Emphasis on geometric aspects, including two-dimensional manifolds, the fundamental group, covering spaces, basic simplicial homology theory, the Euler-Poincare formula, and homotopy classes of mappings. P: Math 551 and 542.

561 Differential Geometry. II, Even Yrs; 3 cr (N-A). Theory of curves and surfaces by differential methods. P: Math 320 or 340; and Math 521.

565 Convex Figures and Inequalities. Irr; 3 cr (N-A). Simplest geometrical properties of convex figures and their applications to the fundamental inequalities in use in everyday mathematical analysis. P: Math 320 or 340.

567 Elementary Number Theory. II, Even Yrs; 3 cr (N-A). Fundamental theorem of arithmetic, quadratic residues and quadratic reciprocity, number-theoretic functions, certain diophantine equations, Farey fractions, continued fractions. P: Math 340 or con reg.

571 Mathematical Logic. (Crosslisted with Philos 571.) II; 3 cr (H-A). Basics of logic and mathematical proofs; propositional logic; first order logic; undecidability. P: Math 223 or equiv.

623 Complex Analysis. I; 3 cr (N-A). Elementary functions of a complex variable; conformal mapping; complex integrals; the calculus of residues. P: Math 321 or 521.

629 Introduction to Measure and Integration. II; 3 cr (N-A). Lebesgue integral and measure, abstract measure and integration, differentiation, spaces of integrable functions. P: Math 522.

632 Introduction to Stochastic Processes. (Crosslisted with Business, Ind Engr, and Stat 632.) I, II; 3 cr (N-A). Markov chains: classification, recurrence, transcience, limit theory. Renewal theory, Markov processes, birth-death processes. Applications to queueing, branching, and other models in science, engineering and business. Topics drawn from semi-Markov processes, martingales, Brownian motion. P: Math 431, or Stat 309 & 310, or Stat 311 & 312, or Stat 313 or 314.

633 Queuing Theory and Stochastic Modeling. (Crosslisted with Ind Engr, Business 633.) Irr; 3 cr (N-A). Reliability theory; coherent systems and reliability bounds. Markovian queues and Jackson networks. Steady-state behavior of general service time queues. Priority queues. Approximation methods and algorithms for complex queues. Simulation. Dynamic programming; applications to inventory and queueing. P: Math, Ind Engr 632 or cons inst.

641 Introduction to Error-Correcting Codes. (Crosslisted with E C E 641.) Irr; 3 cr (N-A). A first course in coding theory. Linear codes, decoding and encoding. Hamming codes, Shannon's theorem on the existence of good codes. The binary Golay code. Finite fields and BCH codes. Dual codes and the weight distribution. Cyclic codes: generator polynomial and check polynomial. Reed-Solomon codes and burst errors. The Euclidean algorithm for decoding BCH

U Wisconsin 1994-96

codes. Reed-Muller codes. P: Math 320 or 340; and Math 541 or cons inst.

681 Senior Honors Thesis. I, II, SS; 3 cr (N-A). P: Sr st & enrollment in the honors program.

682 Senior Honors Thesis. I, II, SS; 3 cr (N-A). P: Cons inst.

699 Directed Study. I, II, SS; 1-6 cr (A). P: Jr or Sr st. Graded on a lettered basis; requires cons inst.

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